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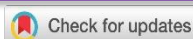
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The Influence of the Critical-Collaborative Learning Model (CCLM) on Students' Creative Thinking Ability

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Abstract

This study aims to determine the effect of the Critical-Collaborative Learning Model (CCLM) on students' creative thinking abilities in thermodynamics material. The research employed a quantitative approach using a quasi-experimental method. The subjects of this study were grade XI students of Madrasah Aliyah Negeri (MAN), with data collection instruments in the form of essay questions designed to measure students' creative thinking abilities. The results indicated that the average score of the experimental class (85.5%) was higher than that of the control class (68.9%). The data were tested for normality and homogeneity, showing that the data were normal and homogeneous. Subsequently, the Independent Sample T-test revealed a significance level of 0.000, which is less than Sig. < 0.05, meaning that H0 is rejected and H1 is accepted. Thus, it can be concluded that the use of the Critical-Collaborative Learning Model (CCLM) significantly affects students' creative thinking abilities.

Keywords: Creative Thinking Ability; Critical-Collaborative Learning Model; Student Achievement.

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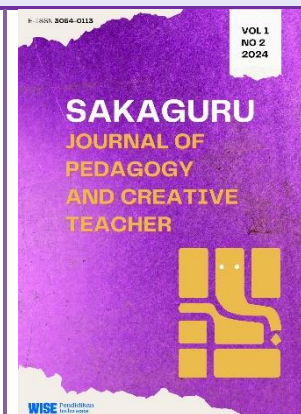
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INTRODUCTION

Education is one of the processes for improving the quality of a nation's life, aiming to develop individuals with noble character and creative thinking skills to enhance their personal, national, and global stature [1], [2], [3]. In the increasingly modern and advanced era, education has become essential for human development, as a lack of education can hinder effective socialization and communication processes [4]. Learning is the process of interaction between educators and students, along with learning resources, within a learning environment [5], [6], [7]. Learning serves as the assistance provided by educators to facilitate the acquisition of knowledge, mastery of skills, and the development of attitudes and beliefs among students [8].

One of the subjects that must be studied is Physics, which is the science that explores natural phenomena. Physics instruction should emphasize the concepts of physics based on the essence of science, which involves products, processes, and scientific attitudes [9]. Therefore, it is crucial for teachers to optimize students' creative thinking competencies in science learning. Creative thinking refers to an individual's ability to analyze new information and combine unique ideas or concepts to solve problems [10]. Each student undoubtedly possesses different levels of skills. An individual's creative thinking skills will continue to develop in tandem with the maturity of their thinking patterns and cognitive structures, which are directly related to their level of understanding of a concept. Therefore, measuring students' creative thinking skills is necessary [11]. The ability to think creatively, as defined in the PISA study, ranges from level 4 to level 6. Based on this data, it can be concluded that Indonesian students' creative thinking ability is still very low. The results of PISA assessments are closely related to creative thinking abilities, as PISA tasks are contextual problems that require reasoning, argumentation, and creativity to solve. Hence, PISA results can reflect students' creative thinking abilities [12].

In enhancing students' knowledge and understanding, efforts such as curriculum changes, the use of concrete methods and models that are more relatable to students, and the provision and development of educational media or learning tools are essential [13], [14]. One way to improve students' creative thinking skills is through the use of learning models and instructional media, enabling them to adapt to 21st-century learning as a solution to address the Fourth Industrial Revolution (Industry 4.0). This revolution facilitates continuous, effective learning processes without being limited by space and time [15]. Therefore, the researchers aim to enhance students' creative thinking skills by employing the *Critical-Collaborative Learning Model (CCLM)* [16]. The selection of an appropriate learning model plays a crucial role, particularly in developing students' reasoning, engagement, and learning motivation [17].

A previous study by Rusdi Hasan, Marheny Lukitasari, Sri Utami, and Anizar Anizar, titled "*The Activeness, Critical, and Creative Thinking Skills of Students in the Lesson Study-Based Inquiry and Cooperative Learning*," revealed that Lesson Study (LS)-based inquiry learning is more effective in enhancing students' critical and creative thinking skills compared to LS-cooperative learning. Although both models showed improvements in student activeness during the learning cycles, no significant differences were observed in this aspect [18].

However, several research gaps remain to be addressed. Firstly, the study did not explore learning models such as the Critical-Collaborative Learning Model (CCLM), which has the potential to integrate inquiry and collaboration approaches for a more comprehensive development of critical and creative thinking skills. Secondly, the study is limited to a local context and has not examined the impact of such learning models on specific subject matters,

such as thermodynamics, which demands higher levels of creativity. Additionally, the evaluation of creative thinking skills could be enhanced by incorporating more advanced instruments, such as PISA-based questions, to assess higher-order creative thinking skills. Future research could fill these gaps to provide more significant contributions to the advancement of 21st-century education.

The researcher conducted a preliminary study in class XI MIA at MAN 1 Pringsewu by administering a creative thinking ability test. The results of the preliminary study indicated that students' creative thinking abilities at MAN 1 Pringsewu were still low. The average scores of the students were below expectations, reflecting that classroom teaching and learning activities had not yet reached their optimal potential. This was evidenced by the inability of students to adequately solve essay questions that required creative thinking skills. Based on the above explanation, the researcher conducted a study titled *"The Influence of the Critical-Collaborative Learning Model (CCLM) on Students' Creative Thinking Ability."* The primary objective of this study is to determine the effect of the Critical-Collaborative Learning Model (CCLM) on students' creative thinking abilities in thermodynamics material.

METHODS

This research is a quantitative study employing a quasi-experimental method aimed at obtaining empirical information [19]. A quasi-experiment refers to a research approach that employs techniques and procedures to collect data in a structure similar to an experiment but without controlling the participants' conditions and experiences, as it relies solely on random assignments. The quasi-experimental method in this study utilizes a Nonequivalent Control Group Design, involving two classes: an experimental class and a control class [20].

Table 1. Research Design

Pretest	Treatment	Posttest
O1	C	O3
O2	X	O4

In this study, the research population comprised students of grade XI MIA during the second semester at MAN 1 Pringsewu for the 2023/2024 academic year. The research sample consisted of two classes selected from the population: class XI MIA 4 with 34 students as the experimental group and class XI MIA 2 with 34 students as the control group. The sampling technique used in this research was Simple Random Sampling, a technique that involves selecting subjects or samples randomly from the population [21].

The data collection techniques employed in this study included test instruments in the form of essay questions designed to assess creative thinking abilities in thermodynamics and non-test instruments, such as evaluation questionnaires for the Critical-Collaborative Learning Model (CCLM). Data collection utilized Likert-scale questionnaires, while the essay test results measured creative thinking skills across specific aspects. The test instruments underwent validation using the product-moment formula and reliability testing with Cronbach's Alpha, yielding 10 valid questions with high reliability criteria.

The data analysis techniques involved prerequisite tests and hypothesis testing. The prerequisite tests included normality testing using the Kolmogorov-Smirnov test and homogeneity testing with Levene's Statistic. Hypothesis testing was conducted using the t-test

or Independent Sample t-test for normally distributed data, with a significance level of 0.05 or 5%. The calculations in this study were performed with the assistance of SPSS version 25.

RESULT AND DISCUSSIONS

Result

The study was conducted by first administering a pretest to students to assess their creative thinking abilities. In subsequent sessions, the learning process was carried out using the Critical-Collaborative Learning Model (CCLM) in the experimental class and a conventional learning model in the control class. After each class received the respective instructional treatments, the students then completed a posttest. This approach was undertaken to collect data on the activities and performance of students engaged in learning using the Critical-Collaborative Learning Model (CCLM) compared to those in the conventional learning model. The following presents the results of the descriptive statistical analysis of the pretest and posttest data on students' creative thinking abilities:

Table 2. Pretest-Posttest Results of Creative Thinking Skills in Experimental and Control Classes

Indicator	Control				Experimental			
	Pretest		Posttest		Pretest		Posttest	
	Average Score	Criteria	Average Score	Criteria	Average Score	Criteria	Average Score	Criteria
Fluency	41%	Moderately Creative	74%	Creative	36,6%	Less Creative	84,5%	Highly Creative
Flexibility	35,5%	Less Creative	75%	Creative	33%	Less Creative	86,5%	Highly Creative
Originality	38%	Less Creative	66,6%	Creative	38,6%	Less Creative	81,6%	Highly Creative
Elaboration	38%	Less Creative	63,6%	Creative	38%	Less Creative	85%	Highly Creative

The table above shows that the average pretest scores for each creative thinking skill indicator in the control and experimental classes indicate that the control class had higher average pretest scores than the experimental class. However, the average posttest scores for each indicator in the experimental class were higher than those in the control class.

Based on the average pretest and posttest scores for each creative thinking skill indicator, it can be concluded that the posttest averages for each indicator were higher than the pretest averages. This improvement is attributed to the different treatments applied during the learning process, resulting in higher posttest averages across all creative thinking skill indicators. Notably, the experimental class, which implemented the Critical-Collaborative Learning Model (CCLM), achieved higher posttest averages compared to the control class, which used the conventional learning model.

Before testing the hypothesis, prerequisite tests were conducted, starting with a normality test using SPSS version 25 to determine whether the data followed a normal distribution. Following the normality test, a homogeneity test was performed to evaluate whether the data were homogeneous. Lastly, hypothesis testing was conducted using a t-test. The results of the normality test were calculated using the Lilliefors method, with a

significance level of 0.05 or 5% as the decision criterion. H1 was accepted if the calculated $L_{calculated}$ was smaller than the critical L_{table} .

Table 3. Normality Test Results for Experimental and Control Classes

Class	N	$L_{calculated}$	L_{table}	Description
Pretest Experimental	34	0.098	0.151	Data Follows a Normal Distribution
Posttest Experimental		0.141		
Pretest Control		0.095		
Posttest Control		0.109		

Based on the results of the normality test calculations with a significance level of 0.05 or 5%, it can be observed that the $L_{calculated}$ value for the experimental class pretest is 0.098, while for the posttest, it is 0.141. For the control class, the pretest $L_{calculated}$ value is 0.095, and the posttest value is 0.109. Given that the L_{table} value is 0.151, both the experimental class, which employed the Critical-Collaborative Learning Model (CCLM), and the control class, which used the conventional learning model, demonstrated normal data distribution since all $L_{calculated}$ values were less than L_{table} .

Next, a homogeneity test was conducted to determine whether the data used in this study were homogeneous. Below are the results of the homogeneity test.

Table 4. Homogeneity Test Results for Experimental and Control Classes

Levene Statistic	df1	df2	Sig.
0.134	1	66	0.716

The results of the homogeneity test shown in the table above indicate that the significance value of the variance is greater than 0.05. This means that the creative thinking abilities of students from both samples are considered homogeneous.

The next step, after prerequisite tests confirming the data's normality and homogeneity, was hypothesis testing. The hypothesis test was conducted using a t-test to determine whether there were differences and effects of the Critical-Collaborative Learning Model (CCLM) implemented in the experimental class compared to the conventional learning model used in the control class. The decision rule for the t-test states that H1 is accepted if the significance value is less than 0.05 or 5%. Below are the results of the t-test:

Table 1. T-Test Results for Experimental and Control Classes
Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Creative Thinking	Equal variances assumed	.098	.755	-4.2	66	.000	-8.00	1.8	-11.792	-4.208

Equal variances not assumed	-4.2	65.9	.000	-8.00	1.8	-11.792	-4.208
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Based on the results of the independent t-test calculations using SPSS version 25, and referring to the decision rule where the significance value (2-tailed) < 0.05 , it can be concluded that the significance value from the calculations in Table 5 is 0.000, which is smaller than 0.05. Therefore, it can be stated that the Critical-Collaborative Learning Model (CCLM) has a significant effect on students' creative thinking abilities in thermodynamics material.

Discussions

Based on the research conducted on students at MAN 1 Pringsewu, the findings indicate that the application of the Critical-Collaborative Learning Model (CCLM) has a more positive impact on students' creative thinking abilities compared to the conventional learning model. The analysis and measurement of pretest and posttest scores on students' creative thinking abilities revealed significant differences. The pretest was administered prior to the treatment, while the posttest was given afterward. The results demonstrate that posttest scores were higher than pretest scores. Both the control class and the experimental class showed different outcomes. Below are the average results for each indicator, presented in the graph below:

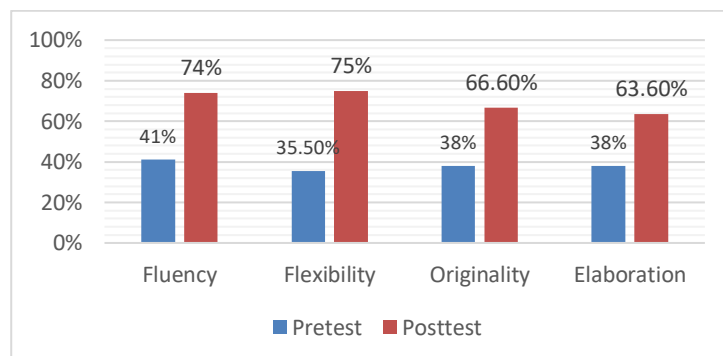


Figure 1. Graph of Pretest-Posttest Data for the Control Class

Based on the graph above, the average pretest and posttest results for the control class across each indicator are as follows: **fluency** improved from 41% in the "moderately creative" category to 74% in the "creative" category, **flexibility** increased from 35.5% in the "less creative" category to 75% in the "creative" category, **originality** rose from 38% in the "less creative" category to 66.6% in the "creative" category, and **elaboration** advanced from 38% in the "less creative" category to 63.6% in the "creative" category.

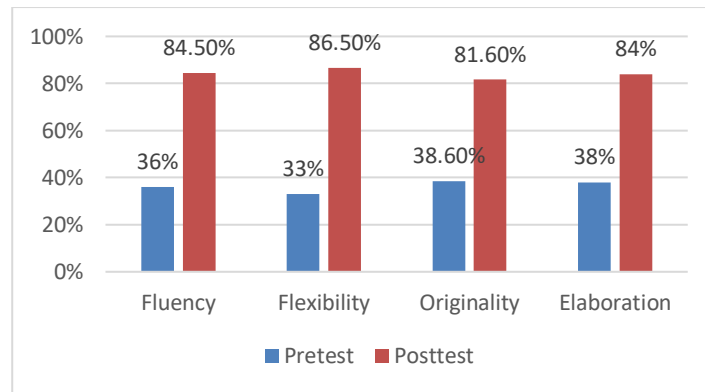


Figure 2. Graph of Pretest-Posttest Data for the Experimental Class

Based on the graph above, the results indicate a significant increase in the average posttest scores for the experimental class across each indicator. For creative thinking indicators, **fluency** improved from 36% in the "less creative" category to 84.5% in the "highly creative" category, **flexibility** rose from 33% in the "less creative" category to 86.5% in the "highly creative" category, **originality** increased from 38.6% in the "less creative" category to 81.6% in the "highly creative" category, and **elaboration** advanced from 38% in the "less creative" category to 84% in the "highly creative" category.

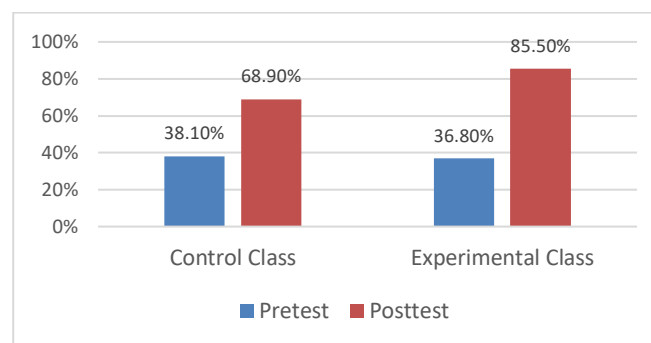


Figure 3. Graph of Average Pretest-Posttest Percentage Data

Figure 3 above illustrates the percentage results of pretest and posttest scores for each class. The control class showed an increase of 30.8%, from 38.1% to 68.9%, whereas the experimental class experienced a significant increase of 48.7%, from 36.8% to 85.5%.

This improvement in students' performance is attributed to the learning process, during which the teacher provided motivation and encouragement to build students' confidence in their own abilities. In the experimental class, nearly all students were actively engaged and capable of solving the problems presented. This was due to the implementation of the Critical-Collaborative Learning Model (CCLM), which encouraged students to work collaboratively in groups and granted them the freedom to explore learning resources or references from various sources. This approach broadened their understanding of the thermodynamics material.

The study demonstrated that the use of the Critical-Collaborative Learning Model (CCLM) in the experimental class significantly enhanced students' creative thinking skills in thermodynamics. This model proved effective in fostering creativity by incorporating several instructional components, including collaboration, literacy, discussion, creation, and action. Through this model, students were encouraged to explore thermodynamics concepts from

multiple reference sources and to exchange information during group discussions, leading to an enriched knowledge base and improved creative thinking abilities.

In contrast, the control class, which used a conventional teaching model, was less effective in fostering creative thinking skills in thermodynamics. The reliance on lecture-based teaching methods limited the potential for active student engagement, resulting in less optimal learning outcomes.

CONCLUSION

The findings of this study indicate that the Critical-Collaborative Learning Model (CCLM) significantly enhances students' creative thinking abilities in physics learning for grade XI students at MAN 1 Pringsewu. Hypothesis testing showed a significance value of ≤ 0.05 , leading to the rejection of H_0 and acceptance of H_1 , confirming a notable improvement in students' creative thinking skills after the intervention. Future research could expand on these findings by integrating digital tools within the CCLM framework, exploring its applicability across different subjects and educational levels, or conducting longitudinal studies to assess its long-term impact. Additionally, practical implementation guidelines and teacher training programs should be developed to ensure broader adoption and scalability. Comparative studies with other collaborative learning models may also provide valuable insights into refining the approach for diverse educational contexts.

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CONFLICT OF INTEREST

"The authors declare no conflict of interest."

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